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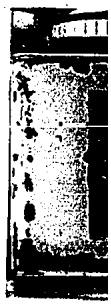

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SOURCE Vizugyi Kozlemenyek, (Hydraulic Proceedings), Vol I, 1951.

IRRIGATION IN HUNGARY

Arpad Trummer

[Tables referred to are appended.]

The proposed development of irrigation under the Five-Year Plan has confronted Hungarian hydraulic engineers with the problem of estimating the acreage which can be placed under irrigation within Hungary's present borders. As is well known, conclusions on this subject depend on two principal factors, namely, the volume of water allocated per unit of land to be irrigated during the irrigation season and the capacity of the water sources (streams, wells, reservoirs, etc.). It may be added that the quantity of water allotted for irrigation depends also on the type of crop and soil; however, the latter question is of secondary importance in the present study.

It has been customary to measure the water supply in terms of a theoretical constant flow per unit of area. The unit of measurement employed is the liter per second. Although this theoretical unit is usually disregarded in practice, the concept has been retained throughout this study, because it is suitable for calculating the relationship between the permanent volume of available water and the area to be irrigated.

In the USSR, the necessary quantity of irrigation is expressed by an annual norm as, for example, 6,000 cubic meters per year. This method may simplify matters from the viewpoint of the farmer, but it complicates the work of determining the acreage which can be irrigated by a given water supply. To calculate the acreage, the total volume of irrigation water must be measured and divided by the norm of annual consumption, or by the average of the norms, in case of several kinds of crops. However, these measurements are important only to the engineers who are planning or directing the irrigation systems, while the farmer is interested mainly in the length of the period during which he is permitted to use irrigation water. He must also have an irrigation schedule and calendar, without which the annual quota would have only a theoretical meaning.

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In early 1930, the total area of irrigable land in Hungary was estimated by Udo Ruttkay at 2 million cadastral yokes. Subsequently, Arpad Ujlaki Nagy estimated that by using sprinkling irrigation, 4.5 million cadastral yokes of the Hungarian Plain could be irrigated; this estimate would equal 1.7-1.8 million cadastral yokes by nonsprinkling methods. Both authorities based their estimates on rather low annual norms. Ujlaki Nagy worked with a norm of 1,500 cubic meters per cadastral yoke, or 2,600 cubic meters per hectare, and Ruttkay, with a norm of 3,000 cubic meters per hectare. These figures appear to be too low when the soil conditions and the great distances over which the water must be conducted are taken into consideration.

The Ministry of Agriculture, in implementing the water law of 1885, set the norm at 4,000 cubic meters per cadastral yoke (6,900 cubic meters per hectare). Subsequently, the landowners asked for an increase in norm, which was granted in 1914.

It is obvious that, given the same soil conditions and crop, the volume of water is the most important single factor in determining the extent of the irrigable area. In 1935, the author published a study (1) containing the first estimate based on the volume of water. In this study, the volume of water available for irrigation was estimated at 224 cubic meters per second and the acreage which could be irrigated without storage facilities at 360,000 cadastral yokes in the Tisza Valley and at 500,000 cadastral yokes in the Danube Valley, or a total of 860,000 cadastral yokes.

The subject matter of the above study was the annual norm and the measurement of the constant water flow. On the basis of an annual water level of 400-500 millimeters, the norm of irrigation water was estimated at 2,300 - 2,875 cubic meters per cadastral yoke (4,000-5,000 cubic meters per hectare) of arable and grass lands. The constant flow was estimated at 0.25 liter per second per cadastral yoke (0.43 liter per second per hectare) for hard, trans-Tisza soils and at 0.33 liter per second per cadastral yoke (0.57 liter per second per hectare) for loose, trans-Danubian soils.

During the 15 years since the publication of the study mentioned above, the problem has been examined by various researchers in connection with the irrigation system set up by law in 1937 and on the basis of the provisions of the first Five-Year Plan. As a result, the problem can be dealt with at present in the light of further data. Attention is called to the fact that the border rivers were not included in the author's study of 1935. In the present study, however, their volume of water has been taken into account at half value.

An important difference exists in the use of water for irrigation or for power production. In power production, the same water can be used several times, depending on the slope of the group. In irrigation, on the other hand, the water is used up completely or to a great extent the first time and does not return to the stream. Another important difference is that in power production, water can be used even at its minimum volume, since a decrease in the water level causes, at worst, a reduction in power output. Crops, however, cannot sustain a reduction of over 25-30 percent in irrigation water. As a result, in contrast to the practice in water power production, the annual mean water volume cannot be taken as a basis for planning in irrigation. Even though low water volume occurs only once in every 15-20 years, it is advisable in irrigation planning to take the lowest observed volume of a given stream, increase it by 25-30 percent, and use this theoretical minimum in estimating the extent of the irrigable areas.

In estimating the minimum water volumes of various streams, the author made use of the data published by the Vizrajzi Intezet (Hydrographic Institute), Jozsef Korbely, and others. The minimum water volumes are given in Table 1, Column 2, while Column 3 contains the minimum volumes required for irrigation.

The water volumes of small streams are very difficult to estimate, because data for their minimum volumes is not available. According to statistics published by the Civil Engineer's Office, there are 7,200 kilometers of small streams in Hungary; however, it is also known that these streamlets are completely or nearly dry during the main irrigation season in July and August. The author estimated the constant water volume of streams and artesian wells during the irrigation season in the trans-Tisza region at 5,000 liters per second and in the trans-Danubian region at 8,000 liters per second.

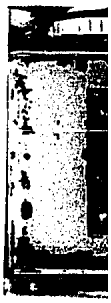
Zoltan Babos (2) states that out of a total of 60 cubic meters per second, 25 cubic meters can be utilized for irrigation. He indicates a sizable amount of ground water, without giving a specific estimate. Since ground water in the trans-Tisza region sinks to a considerable depth and cannot readily be made available for irrigation, the author took ground water into account only for the trans-Danubian region. According to the author's estimates, 1,000 liter per second can be utilized from artesian wells, 8,000 liters per second from streams, and 4,000 liters per second from ground water.

Babos estimated the irrigable area at 1.5 million cadastral yokes with storage facilities and at 720,000 cadastral yokes without storage, basing his figures on water volumes obtained from streams and excluding artesian wells, ground water, inland lakes, and reservoirs. He assumed an irrigation season of 123 days and a constant flow of 0.25 liters per second per cadastral yoke. In the author's view, these assumptions are valid on a national scale only if strict economy in the use of irrigation water is observed. Babos' findings correspond to an irrigation water supply of 2,630 cubic meters per cadastral yoke.

During the last decade, a number of experts investigated the irrigation water supply from the geological viewpoint and in reference to agricultural production. Endre Nemeth (3) estimated the constant water flow in the trans-Tisza region at an average of 0.29 liters per second per cadastral yoke (0.50 liters per second per hectare). This value is 16 percent higher than the 0.25 liter per second which the author estimated in 1935 and 17 percent lower than the 0.35 liter per second estimated in 1932 by Gasparin in France for hard soils.

Table 1 shows the amount of water available for irrigation without storage and the irrigable area, on the basis of the lowest observed water volume, increased by 25-30 percent. In the case of certain rivers (the Drava, Mura, Maros, and Ipoly), the author's estimate was based on the irrigable area instead of on the volume of water.

The constant water flow varies between 0.30 and 0.50 liter per second per cadastral yoke, with the average closer to the lower figure, because sources with a small yield play a large role in irrigation. The author's estimate is based on the assumption that the entire minimum water volume of the Tisza River is available for irrigation. Currently, navigation on the Tisza is suspended during periods of low water level, which is synonymous with a low water volume, and, therefore, the water which is insufficient for navigation may as well be used for irrigation. For the Danube and Drava rivers, on the other hand, the author's estimate included only the volume of water which left the water levels of these rivers at the minimums established by international agreements.



The volume of irrigation water may be increased by storage facilities. Possibilities exist for building reservoirs in the Bukk and Matra mountains, as well as in certain valleys of the trans-Danubian region. However, the volume which could be accumulated in the Bukk and Matra would be less than 10 cubic meters per second; in the trans-Danubian area, the figure would be half that amount.

Stored water is exposed to evaporation at a substantial rate, depending on the surface area and depth of the reservoir. In the trans-Tisza region, for example, it was planned to build storage facilities containing 220 million cubic meters of water with a surface area of 14,000 cadastral yokes, that is, 80,640,000 square meters. Evaporation from these reservoirs during the irrigation season was estimated at 700 millimeters, equivalent to a loss of 56 million cubic meters, or 25 percent of the total stored, leaving 164 million cubic meters available for irrigation. If this volume is used over a period of 4 months (May through August), then the constant volume of water is

$$\frac{164,000,000}{120 \times 86,400} = 15.82 \text{ cubic meters per second}$$

which, at a constant flow of 0.25 liter per second per cadastral yoke, is adequate for irrigating 64,000 cadastral yokes (37,000 hectares). The annual quantity of water available for one cadastral yoke is, therefore,

$$\frac{220,000,000}{64,000} = 3,440 \text{ cubic meters},$$

of which, after subtracting loss by evaporation, 2,600 cubic meters per cadastral yoke (4,500 cubic meters per hectare) remain available for irrigation.

In Table 2, the author estimated the possible maximum volume of reservoir water in the trans-Tisza region at 310 million cubic meters, including the 220 million cubic meters already planned. This theoretical total of 310 million cubic meters would correspond to a constant volume of 30 cubic meters per second and would be sufficient to irrigate 90,000 cadastral yokes. While this volume is somewhat less than the national average without storage facilities, the water would be used on hard soil, where it is necessary to guard against overirrigation.

It is obvious that accumulation of 610 million cubic meters of water may be counted on. This would correspond to a constant water volume of 137 cubic meters per second, sufficient to irrigate 400,000 cadastral yokes.

In one type of storage system, the water is stored in immediate local requirements (local storage). In another type, the water accumulated in a reservoir is distributed by a network of canals. It is also possible to differentiate between semiannual storage, usually in connection with wells, and seasonal storage, when the surplus water accumulated during the spring is stored for the summer drought.

Local storage amounts to 5,760 h cubic meters of water per cadastral yoke, where h represents the depth of the stored water in meters. The value of h for small reservoirs is usually 2 meters; in large reservoirs it is 2.5 to 3 meters.

In semiannual storage, with a water volume of one liter per second per cadastral yoke,

$$\frac{180 \times 86,400 \times 1.0}{1,000} = 15,552 \text{ cubic meters}$$

with a depth of 2.7 meters are stored. With an easily realized water depth of 2.10 meters, 12,000 cubic meters of water can be accumulated, sufficient for the irrigation of 3 cadastral yokes. With a depth of 2.70 meters and a surface area of one cadastral yoke, 4 cadastral yokes can be irrigated. By means of local storage, at a constant water flow of one liter per second, adequate irrigation is available for 6 cadastral yokes. By accumulating a 6-month supply of water from artesian wells, an area five to six times greater than the surface area can be irrigated.

It would seem advisable to introduce and expand local storage in the producers' cooperatives. In case of seasonal storage, for example, by utilizing the flood waters of the Tisza or of the inland lakes which form in the spring, it would be possible to accumulate in an area of one cadastral yoke as much water as the duration of the flood or the volume of the inland lake will allow. Taking the h factor at a value of 3 meters -- which on the Hungarian Plain is generally the maximum -- the accumulated water would total 17,280 cubic meters per cadastral yoke. Of this gross quantity, 13,000 cubic meters can be utilized, sufficient for the irrigation of $\frac{13,000}{3,800} = 3.6$ cadastral yokes. To allow for a margin of safety, 3.3 cadastral yokes were taken as a basis.

It may be noted that a 5-month (153-day) irrigation season at 0.30 liter per second would require 4,000 cubic meters of water per cadastral yoke according to the following formula:

$$\frac{13,219,200 \times 0.33}{1,000} = 3,966 \text{ cubic meters per cadastral yoke,}$$

where the figure 13,219,200 denotes the number of seconds. In a 4-month period (123 days), this value decreases by 20 percent and is still sufficient to satisfy the requirements of all crops grown on arable lands. For this reason, in planning the state irrigation project in the trans-Tisza region, the constant of 0.30 liter per second has been accepted, providing 4,000 cubic meters of water annually per cadastral yoke (7,000 cubic meters per hectare).

In the author's opinion, the trans-Tisza estimate cannot be applied on a national scale. The loose soil in the trans-Danubian region, the soil improvement program, and the higher development of agrotechnology -- designed to loosen the soil -- combine to caution in proceeding with the expansion of irrigation.

Table 3, prepared in connection with Tables 1 and 2, comprises water supply available both with and without storage. As shown in the table, the national water supply available for irrigation totals 390 cubic meters per second and is sufficient to irrigate 1,137,000 cadastral yokes (655,000 hectares) without restrictions. The constant flow is 0.343 liter per second per cadastral yoke, corresponding to 4,534 cubic meters annually per cadastral yoke (7,876 cubic meters per hectare), on the basis of a 5-month irrigation season (15 April to 15 September). This volume appears to be adequate for the country as a whole.

In the following paragraphs, the author's estimate will be examined in the light of additional available data.

Zoltan Balos (4) estimated the constant water supply available for irrigation without storage at 417 cubic meters per second. The difference of 27 cubic meters between this figure and the author's estimate obviously stems from the fact that Babos took the entire water supply of border rivers into account, while in Table 1, the water volumes of such rivers are given at half value. The difference between the two estimates is greater in regard to the irrigable area, due to the fact that Babos accepted a constant flow of 0.25 liter per second per cadastral yoke for the entire country, while in Table 3, the national average is shown as 0.34 liter per second.

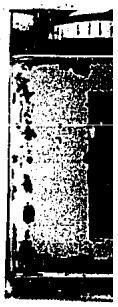
In a joint study by Dr Emil Mosonyi and Istvan Matrai (5), the area which could be irrigated by the canalization of the Tisza River was estimated at 579,000 cadastral yokes. In Table 1, the Tisza Valley area which could be irrigated without storage is estimated at 297,000 cadastral yokes with a flow of 99 cubic meters per second. Assuming canalization of the Tisza, 270,000 cadastral yokes with a water volume of 90 cubic meters per second were added; in other words, the possible maximum area in the Tisza Valley was estimated at 567,000 cadastral yokes with a flow of 189 cubic meters per second. The latter figure corresponds fairly well to the estimate of Mosonyi and Matrai. The two authors estimated the water volume and irrigable area as follows:

Location	Water Volume (cu m/sec)	Irrigable Area (1,000 cadastral yokes)
Upper Tisza	66	221
Tisza canals above Szolnok	31	103
Tisza canals above Szeged	55	183
System of the Koros rivers	18	60
Maros River	4	12
Total	174	579

The average constant flow is 0.30 liter per second or 20 percent greater than Babos' figure, but 13 percent lower than the 0.34 liter per second estimated in the present study.

The two authors concerned themselves -- as indicated by the title of their study -- only with the areas which could be irrigated from the Tisza River and its tributaries and disregarded the water volume which could be obtained from reservoirs, smaller streams, and artesian wells. As a result, their estimate must be revised on the basis of the nationwide supply of irrigation water.

It is true that part of the water used for irrigation -- about 10 percent -- trickles back into the stream and, therefore, again becomes available for irrigation. In practice, however, it is difficult to estimate either the quantity of this water or the point of time at which it can be utilized for the second time. Although the amount of water in question represents the respectable volume of 40 cubic meters per second, the author disregarded it in his estimate in view of the foregoing difficulties.



The Hydrology Department of the Ministry of Agriculture (6) also published an estimate of the water supply available for irrigation, which is reviewed below.

On the basis of Law 1937:XX, it was planned to irrigate 260,000 cadastral yokes with a flow of 77 cubic meters per second from the Tisza and the three Koros rivers. The minimum volume which can be obtained from the Tisza at Tokaj -- excepting a dry period of 25 days annually -- averages 120 cubic meters per second. After deducting 60 cubic meters which are channeled off at Tiszalok, 60 cubic meters remained available for irrigation. After the canalization of the Tisza, a further loss amounting to 10 cubic meters per second will occur due to spillways and evaporation, leaving only 50 cubic meters per second for irrigation. In addition, however, the water stored between the locks will also become available; the lower locks will furnish 136 million cubic feet of water without detriment to navigation. Dividing this volume by the period of the disastrously low water level of 1904, the result is 40 cubic feet per second available for irrigation.

According to these calculations, the water volume of Tisza available for irrigation will increase, in case of canalization, from the estimated 60 cubic meters per second to 150 cubic meters per second, sufficient to irrigate an additional 240,000 cadastral yokes.

According to this official work plan, the section of the Danube between Budapest and Baja has a water volume of 1,000-1,200 cubic meters per second, of which 60-100 cubic meters per second may be used for irrigation with due regard to international navigation agreements. According to previous findings, 250,000 cadastral yokes located along the Danube were suitable for irrigation. The official work plan added 160,000 cadastral yokes and its final results were (in 1,000 cadastral yokes):

Area according to the irrigation law	260
Additional area after canalization of the Tisza	240
Available from the Danube at 60 cubic meters per second	160
Total	660

These areas can be placed under irrigation over a period of 30 years, according to the plan. Accordingly, an average of 22,000 cadastral yokes can be added to the irrigated area each year. Under the plan, the available water supply is represented by the following formula: 77 + 90 + 60 = 227 cubic meters per second, corresponding to a constant flow of 0.344 liter per second per cadastral yoke.

In addition, the following volumes would become available on the basis of Tables 1 and 2 (in cubic meters per second):

Additional volume from:

The Danube	40
The Maros	12
Trans-Danubian streams	52
Reservoirs of the hill regions	15
Local storage	2
Urban sewage	1.6
Total	122.6

Together with the 227 cubic meters per second shown above, this represents a total of 350 cubic meters per second, sufficient to irrigate 1,060,000 cadastral yokes, providing a constant flow of 0.33 liter per second. The foregoing total is only 77,000 cadastral yokes, or 6.8 percent less than the total given in Table 3.

Among older studies, Udo Ruttkay's figures concerning the irrigation of the Hungarian Plain deserve mention (7). Ruttkay lists the irrigable areas in the present boundaries of Hungary as follows (in 1,000 cadastral yokes):

From the Tisza, with storage	1,400
From the Danube	400
From the Raba, Zala, Koros, Maros, and other small rivers, as well as from wells and lakes	400
Total	2,000 [sic]

That this total is considerably greater than my own estimate presented in Table 3 is due to the fact that Ruttkay placed gross irrigation-water requirements [sic] for the entire country at 300 millimeters, equal to 1,728 cubic meters per cadastral yoke. The latter figure is well below my estimate of 2,600, or, including storage, 3,400 cubic meters of annual water supply. If the 1,137,000 cadastral yokes shown in the author's estimate were irrigated by the volume of water estimated by Ruttkay, enough water would be left to irrigate an additional 600,000 cadastral yokes, that is, a total of 1,710,000 cadastral yokes. The two estimates show a difference of only 15 percent, which might be due to difference in detail assumptions.

The 1,137,000 cadastral yokes shown in Table 3, multiplied by 2,600 cubic meters per cadastral yoke, give an annual consumption of 2,960,000,000 cubic meters. On the other hand, Ruttkay's 2 million cadastral yokes, multiplied by 1,728 cubic meters per cadastral yoke, result in 3,460,000,000 cubic meters. The two estimates show a difference of 500 million cubic meters, and if this figure is divided by the length of the irrigation season -- say 7 months -- the resulting yield per second is arrived at according to the following formula.

$$\frac{500,000,000}{215 \times 86,400} = \frac{500,000,000}{18,576,000} = 26.9 \text{ cubic meters per second.}$$

Ruttkay, therefore, estimated Hungary's irrigation-water supply at 417 cubic meters per second, which corresponds to Babos' estimate.

The average water volume arrived at by the four different methods may be represented as follows:

$$\frac{390 + 417 + 350 + 417}{4} = 391.3 \text{ cubic meters per second,}$$

which closely approximates the end total in Table 3.

Under present conditions, the total irrigable area cannot be estimated higher than 1.2 million cadastral yokes. An increase in area could result only from more favorable assumptions; these assumptions may concern the water volume available for irrigation, loss of water in transmission, the annual norm (quantity of irrigation water allotted per unit of area), etc. Since estimates involve large figures, small differences in assumptions may lead to widely varying results.

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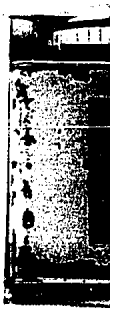

The estimates of water volumes and irrigable areas discussed in the foregoing should be regarded as valid only in reference to the present status of Hungary's national economy. As production and marketing expand with concomitant larger investments, the exploitation possibilities of the country's water supply, together with the irrigation area, will be enhanced.

In the future, the water supply could be stepped up considerably by the canalization of the Danube and Drava. The minimum water supply from these two rivers has been estimated at 1,050 and 255 cubic meters per second, respectively. If these rivers are canalized, 90 percent of the volume, or a total of 1,170 cubic meters per second, will be available for irrigation, sufficient to irrigate 3.5 million cadastral yokes. The Stalingrad and Kuybyshev water power projects on the Volga and the Amu-Darya pumping station justify the expectation that even a river as large as the Danube could be canalized.

A huge amount of water, estimated by Babos at 3.8 liters per second per square kilometer, is, moreover, hidden in the ground under the entire agricultural area. This hidden source of water supply would be sufficient to irrigate 12 cadastral yokes per square kilometer, that is, 6.1 percent. On the basis of this calculation, it is possible to irrigate an additional 400,000 cadastral yokes by ground water.

Should irrigation in Hungary reach an even more advanced stage, the water trickling back from the irrigated fields into the source could be drawn on, adding 20-30 cubic meters per second to the existing water supply and 10 percent to the irrigated area.

These various possibilities may provide irrigation water for 4 million cadastral yokes in addition to the 1.2 million cadastral yokes discussed in the foregoing. The potential total of 5.2 million cadastral yokes would represent 48 percent of the 10.8 million cadastral yokes now under cultivation -- a proportion which has not been attained in any country. (The proportion of irrigated area to the total cultivated area in Lombardy is 30 percent.)

/Appended tables follow/

Table 1. Water Supply Available for Irrigation Without Storage

Name of River Or Other Source Of Water	Water Volume: Min Observed (cu m/sec)	Water Volume: Min Required for Irrigation (cu m/sec)	Irrigable Area: Cadastral Yokes	Irrigable Area: Hectares	Constant Water Flow: Liters per Second per Yoke	Constant Water Flow: Liters per Second per Hectare	Remarks
Tisza Valley							
Tisza at Tokaj	54.0	60.0	180,000	103,700	0.30	0.52	
Hernad-Sajo	8.0	10.0	25,000	14,400	0.40	0.69	Together with Bodva
Koros rivers	6.0	8.0	30,000	17,300	0.27	0.47	
Maros	24.0	12.0	40,000	23,000	0.33	0.57	Border river (half value)
Eger	0.6	0.5	1,000	580	0.50	0.87	
Szamos	--	1.5	3,600	2,070	0.41	0.71	
Tur	--	0.5	1,200	680	0.41	0.71	
Zagyva	0.9	0.6	1,500	870	0.40	0.69	
Hortobagy-Berettyo	--	0.5	1,200	680	0.41	0.71	
Takta Canal	--	0.4	1,000	580	0.40	0.69	
Smaller streams	--	4.0	10,000	5,760	0.40	0.69	
Artesian wells	--	1.0	2,500	1,440	0.40	0.69	
Total	--	99.0	297,000	171,060	0.33	0.58	

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Danube Valley							
Danube	224.0	100.0	300,000	172,800	0.33	0.57	
Raba and Marcal	14.0	12.0	30,000	17,280	0.40	0.69	
Lajta	0.8	1.0	2,000	1,150	0.50	0.87)	Porous soil
Zala	1.9	1.5	3,000	1,730	0.50	0.87)	
Sio	2.0	2.0	5,000	2,880	0.40	0.69	
Kapos-Koppany	0.7	1.0	3,000	1,730	0.33	0.57	
Nador Canal (Sarviz)	0.8	0.8	2,000	1,150	0.40	0.69	
Ipoly	2.5	1.1	3,000	1,730	0.33	0.57	Border river (half value)
Drava-Mura	79.0	25.0	63,000	36,290	0.40	0.69	Partial exploitation
Sewage waters	3.8	1.6	3,000	2,300	0.40	0.69	
Streams and wells	--	8.0	25,000	14,400	0.32	0.56	
Total	--	154.0	440,000	253,440	0.35	0.61	
National total	--	253.0	737,500	424,000	0.34	0.60	Without storage

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Table 2. Areas Irrigable From Storage

Name of River Or Other Source Of Water	Amt of Stored Water (million cu m)	Constant Water Vol (cu m/sec)	Irrigable Area: Cadastral Yokes	Irrigable Area: Hectares	Constant Water Flow: Liters per Second per Yoke	Constant Water Flow: Liters per Second per Hectare	Remarks
Trans-Tisza plains storage	310	30	90,000	51,840	0.33	0.57	Loss by evaporation deducted
Canals of the Tisza	140	90	270,000	155,520	0.33	0.57	Canal storage
Bukk and Matra mountain storage	90	10	25,000	14,400	0.40	0.69	Mountain storage
Trans-Danubian storage	40	5	10,000	5,760	0.50	0.87	Same as above
Local storage reservoirs	30	2	5,000	2,880	0.40	0.69	
Total	610	137	400,000	230,400	0.34	0.60	

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Table 3. National Water Supply Available for Irrigation and Irrigable Area

Type of Water Source	Water Volume (cu m/sec)	Total Irrigable Area		Average Water Flow	
		Cadastral Yokes	Hectares	Liters per Second per Cadastral Yoke	Liters per Second per Hectare
Water supply without storage	253	737,000	424,500	0.343	0.596
Water supply available from storage	137	400,000	230,400	0.342	0.595
National total	390	1,137,000	654,900	0.343	0.596

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